Thermal Control System (TCS) Blanket Interference With Xo 378 Bulkhead Vent Ports

Lessons Learned: 2716

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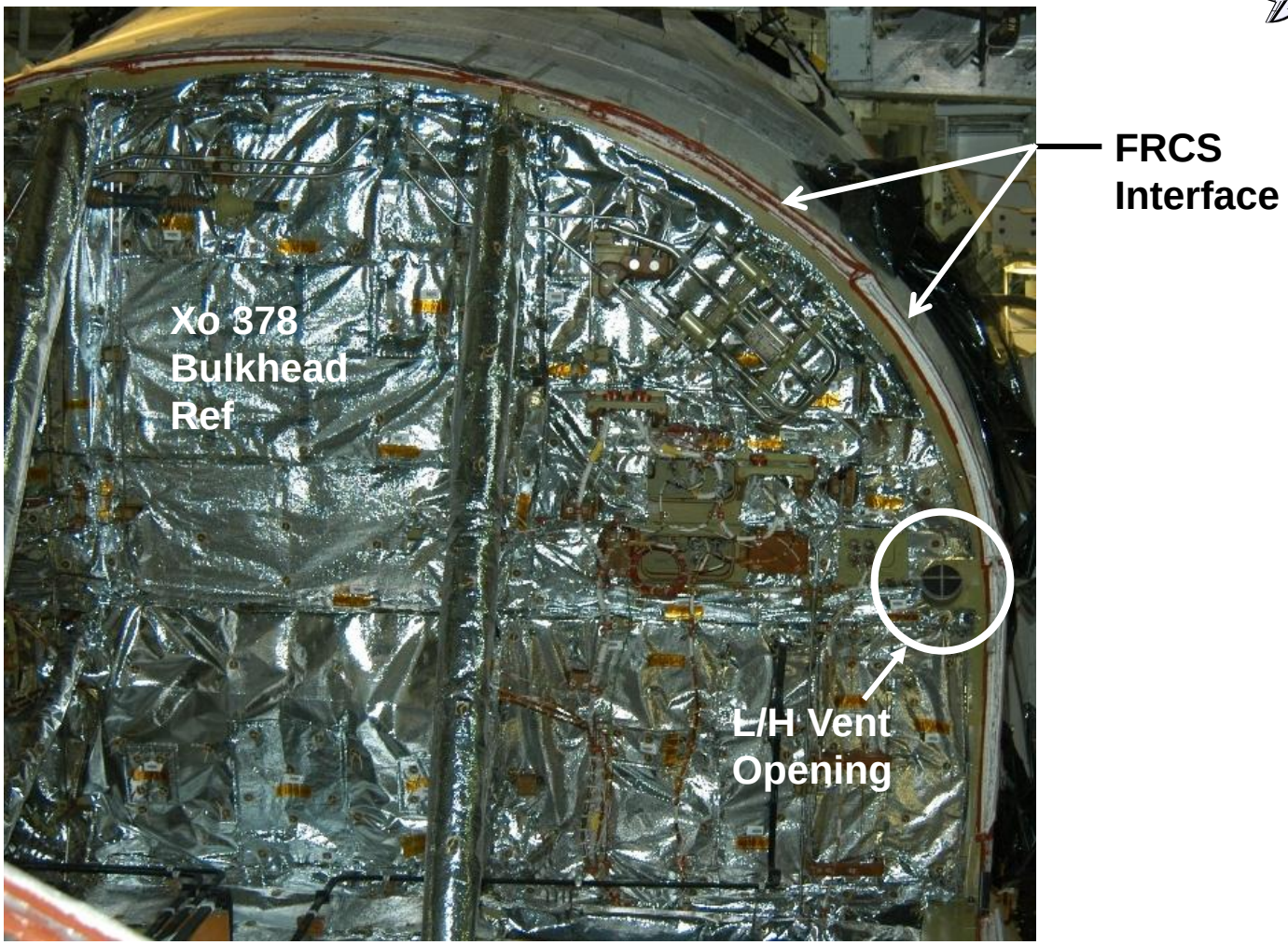
TCS Blanket Interference With Xo 378 Bulkhead Vent Ports

- Thermal Control Subsystem Blankets were installed incorrectly over the purge vent drain (PVD) lines on the Forward Reaction Control System (FRCS) module on OV-103.

- Incorrect installation allowed the TCS blankets to billow into the Xo 378 bulkhead vents, restricting venting of the FRCS cavity during STS-121 ascent.

Looking Aft at Xo 378 Bulkhead



L/H Vent Opening on Xo 378 Bulkhead Shown
R/H Vent Opening Opposite and Symmetrical

Discussion/Investigation of Anomaly

- FRCS blankets V070-361995-024 and -025 were installed and flown on STS-114 (Flt 31) with no anomalies (OV-103 return to flight).
- New blanket configurations required for installation around existing PVD brackets and lines.
- Old configuration blankets were removed (cut out) for structural inspections during obiter major mod (OMM).

- During STS-121 (Flt 32) ascent, the Xo 378 bulkhead delta-pressure transducer showed higher than normal pressure differential across the bulkhead (IFA STS-121-V-11).
  - The actual pressure differential encountered was 1.2 psi. The structure is certified to .95 psi.
  - Blockage of the Xo 378 purge vents from the FRCS side or a faulty pressure transducer were considered the most likely causes.
  - Based on analysis and tests, the orbiter was cleared for landing.

Discussion/Investigation of Anomaly

- Engineering Investigation:
- Corrective Action Record 121RF08 was generated.
  - Pressure transducer was eliminated as cause after landing (by testing).
  - Boroscope inspections on FRC3, during STS-116 (Flt 33) processing, showed that TCS blankets in the FRCS module were very close to the vents and were <u>not</u> installed under PVD drain lines.
    - Design intent is to install the V070-361995-024 (LH) and V070-361995-025 (RH) MLI blankets under PVD drain lines in the FRCS.
    - When properly installed, the blankets are restrained by the PVD drain lines and cannot billow into the Xo 378 vent areas.
    - The blankets contain existing cutouts and cut lines, allowing installation under these lines.
    - Using templates to simulate a Xo378 vent port (on FRC5) TCS engineering determined that blockage of the vent ports can occur when blankets are installed on top of the drain lines.

  •Improper installation of the TCS blankets was determined to be the cause of the vent anomaly.

FRCS Module looking FWD

Blankets Over Drain Line (Incorrect)

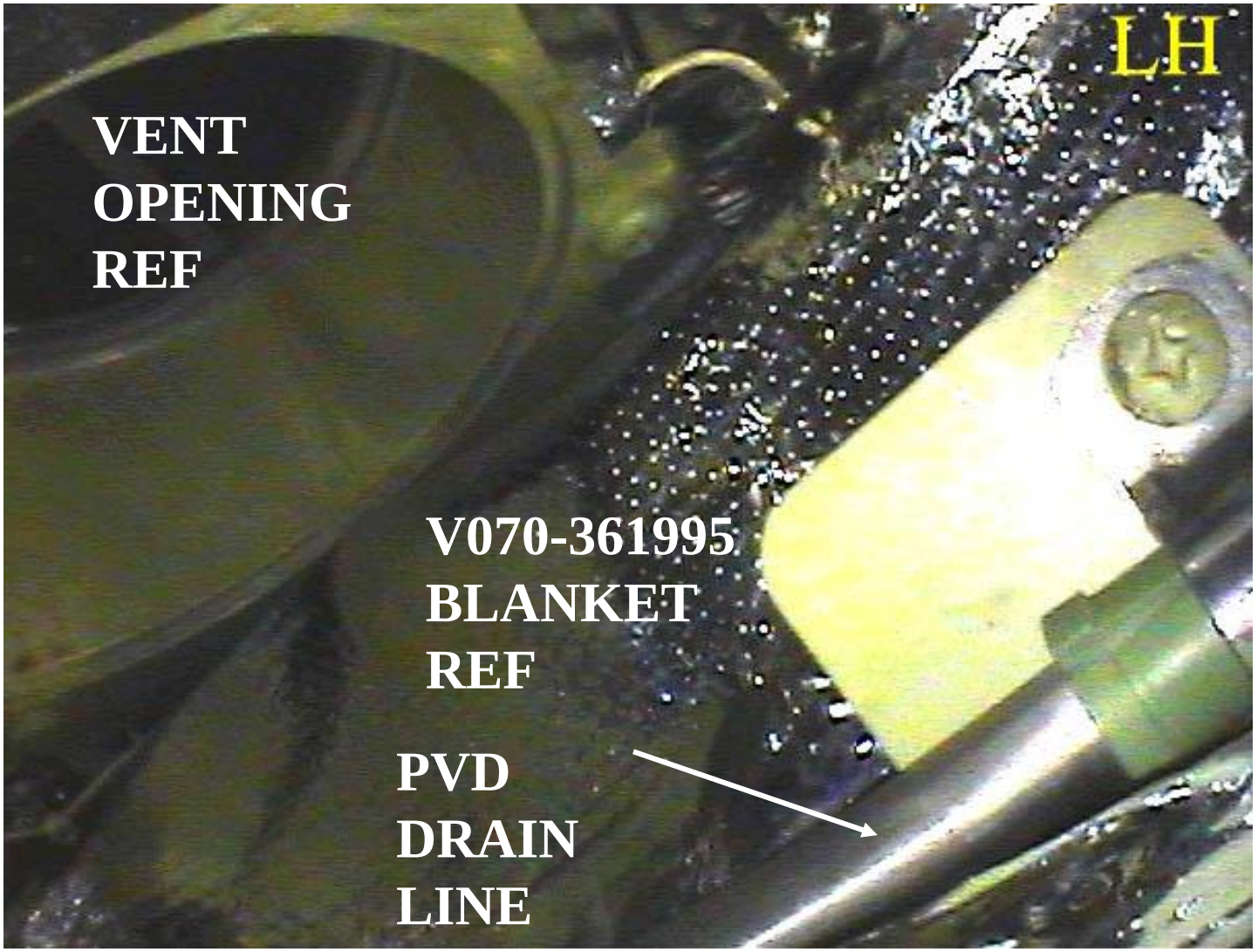
Blankets Under Drain Line (Correct)

Orbiter Xo378 Bulkhead/FRCS Module Interface

BOEING

NASA

Orbiter Xo378 Bulkhead/FRCS Module Interface



How Did Anomaly Occur?

- Why did the venting anomaly occur on STS-121 and not on STS-114?
- Two Unrelated Process control Events:

- Crew cabin leak check on STS-114 revealed cabin air leak from a Xo 378 bulkhead feed-through receptacle.
- Under-torqued electrical receptacle was flown as a restricted condition for STS-114.
- FRC3 was removed during STS-121 processing to remove and replace damaged receptacle.

- FRC3 was transported from Obiter Processing Facility (OPF) to the Hypergolic Maintenance Facility (HMF) for standard fluid line repair.
- During SCAPE operations, a severe oxidizer spill (N_2O_4) occurred. FRCS structure, tile and blankets were damaged.
- Clean-up operations occurred around the clock for the corrosive oxidizer (neutralization).

How Did Anomaly Occur?

- Repair of FRCS hardware after the oxidizer spill:
  - Structural inspection and repair (corrosion clean-up and paint)
  - Tile replacement (bond line degradation)
  - TCS blanket replacement (numerous blankets replaced)
    - New TCS Blankets V070-361995-024 & -025 were incorrectly installed over the PVD drain lines resulting in the STS-121 anomaly.
    - Installation drawing V070-361900 showed blankets V070-361995-024 & -025, but did not specify installation details.

Corrective Action

- Drawing Correction:
- Installation drawing V070-361900 was revised to provide specific blanket installation instructions in order to prevent blanket migration over the PVD purge vents on Xo 378.
- Install blankets under drain lines
- Tie to thruster box blankets using lacing cord and buttons
- Tape to thruster box blankets along inboard seams

- Procedure Correction:
- Blanket Installation/Removal Job Card V63-50049 was updated to provide detailed work steps, as well as cautions and warnings, requiring blanket installation under PVD drain lines.

- Blankets were installed/verified installed per new instructions on all FRCS modules.

Lessons Learned

- Lessons Learned - Understand System Interfaces

- System engineers/operators must understand how their system interfaces with other systems, in order to understand how their contribution affects the entire integrated vehicle system.

- Thermal Control Subsystem Specific
  - The installation of TCS blankets needs to be clearly documented on the installation drawings and procedures so that blankets perform as designed without unintended interferences, particularly in relation to cutouts, openings and mechanisms.
    - Vent Anomaly Example: Orbiter and FRCS are processed by different persons in different buildings.
      - Persons involved in processing never saw or understood the component interfaces.